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ABSTRACT

To determine the statewide need for and the proper emphasis of a teacher education certificate in the area of computer science, a questionnaire was mailed to 459 Oklahoma school districts. Based on 201 usable responses, results indicate a clear demand for computer science teachers, with a demand already existing at the high school level and expected to develop at a starting rate within schools at other levels. Barring severe funding reductions, most public schools plan to have at least some level of computer science instruction in their curriculae within the next five years. Though some of the expanded teaching opportunities will be filled by retraining existing faculty, there appears to be a growing demand for specialists prepared specifically to teach computing. Findings imply a clear need for greater depth and structure in the preparation of new computer science teachers. Teachers should generally be prepared to teach in the broad categories of computer literacy, BASIC programming, and word processing, with further emphasis in either math or business. In line with current and projected demand, teachers should generally be prepared to teach college-bound students, though the need for teachers prepared to teach vocational computing skills will need to be reassessed often. (LMM)

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Computer Science Needs
in the
Public Schools of Oklahoma:
Demands Exceed Supply

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I. The Climate for Computer Education

Schools across the nation are beginning to realize the importance of computing in the curriculum. This trend is not limited to any level of education, but permeates our entire system. Some experts see "education changing more profoundly during the next 10 to 15 years" with learners of all ages "likely to find their homes becoming electronic cottages." (Shane, 1982) The future will find those not able to interact with a computer "less marketable in the world than those who are computer literate." (Christie & Dolan, 1982) The sharp increase in students expected in computer education courses forces educators to prepare to meet the need. As is typical throughout the country, there are few teachers with training or experience in computing. (Lidtke, 1983) As schools offer more and more sections for computer literacy in elementary and secondary schools, the shortage will be compounded.

This would seem to indicate a need for a program to train elementary and secondary teachers to teach at least an introductory course in "computer literacy." Few teachers have had any training in the area of computing. Even the most recent graduates of many pre-service programs are seldom required to take even one course in the area of computing. (Lidtke, 1983) Most states do not require teachers to have any training in computing in order to be certified to teach at the elementary or secondary level. Some states

require as few as six hours of computer courses to teach computer science at the elementary or secondary level. Many of those now teaching computer science were originally math or business majors who took as few as six additional hours of computing in order to be certified in that area.

As the number of students demanding computer education increases, we must be careful to avoid increasing the number of poorly-trained instructors in this area. Therefore, it would seem that a standardized, strengthened program is necessary, with a recent U.S. Department of Education survey showing that "about one school in four now has a computer available for student use," and there is good reason to expect this number to increase rapidly. (National Center for Education Statistics, 1981) This standardized program should prepare teachers to have as their main area of emphasis computer science education while securing a minor in an additional area such as math or business. This additional area would make teachers more desirable to smaller school districts that might need to offer only one or two sections of computer science while using the teacher in an alternate area for the remainder of the day.

Our study was undertaken in order to better understand the existing situation, the needs, and the attitudes of public school administrators relative to the teaching of computer science in the school systems of Oklahoma. The work also grew from a need to prepare a means to increase the quality of computer science instruction statewide.

Casual observation had led to the conclusion that the present quality of instruction covered a very wide range, with some instructors doing a very fine job in the classroom, while there are some instructors who sorely need to upgrade their computer skills. It seems quite obvious that, as with all teaching, a mechanism is needed to assure minimum standards are being met. This study was undertaken with the intention of determining the need for and the proper emphasis of a teacher education certificate program in the area of computer science.

The population from which this sample is drawn is the independent school districts of the State of Oklahoma. A list of the names of superintendents for the school districts was obtained, and a letter and questionnaire were mailed to each person on the list. A total of 459 questionnaires were mailed, and 201 usable questionnaires were returned. With a sample size of 201, the reliability of the study becomes 6.91 percent at the 95 percent confidence level. Such reliability would be considered within the acceptable limits typically used for surveys of this type. Furthermore, a return rate of 43.79 percent is considered to be an excellent response for a mail questionnaire. Thus, the survey provides highly reliable information which can be used to form the basis for a computer science certificate program.

The analysis of the data took the form of a frequency analysis which provides a general overview of the

information for the entire sample. Since a certificate program must be uniform for the whole state, it was felt that proper analysis would examine state-wide needs and not concentrate on the particular emphasis of a region or of districts of a given size. The findings of the frequency analysis are presented in the following sections of this report.

II. Foundations for Teacher Training

Two critical questions face any College of Education proposing to teach computer science to prospective teachers:

- (1) Is there a clear demand within the area served by the college for teachers trained in computing?

and (2) If such a demand does exist, how precisely can it be defined?

Both questions have very practical implications for the College of Education. There seems to be widespread agreement that something called "computer literacy" should be part of the public school curriculum; however, it may not be clear in many states that there is a real market for teachers of computing. As budget cuts restrict the creation of new school programs, the College of Education should be satisfied that it is preparing students to meet specific needs within the state it serves.

If it is generally clear that a market exists for computer science teachers, the College of Education must then try to define carefully what specific training is required. Do the client public schools need teachers who are skilled in mathematics and technical computer science? Or do they seek teachers who specialize in business data processing and programming? There may even be a third alternative: do schools in the area require teachers of computing with a more general background, able to teach "computer literacy" rather than programming or other, more technical disciplines?

Our research begins with these questions. Note that here we are primarily interested in computing as a separate academic subject, rather than as a tool to be used in support of other subjects like math or drafting.

Respondents to the questionnaire were asked to indicate the number of sections of computer science being taught in elementary schools, middle schools, junior high schools, and high schools within their respective school districts. They were also asked to forecast the number of sections that are expected to be taught in the schools five years from now. The results from these two questions are summarized in Table 1.

The evidence in Table 1 clearly indicates that the majority of teaching in computer science has been done at the high school level. Even at that level, the number of sections offered has generally been limited to a single

TABLE 1

Present and Future Number of Computer Science Sections In
Oklahoma Independent School Districts

Schools	Presently						Five Years From Now					
	Number of Sections					Median	Number of Sections					Median
	1	2	3	4 or More*	N/A		1	2	3	4 or More**	N/A	
Elem.	23	1	1	2	174	1.087	58	5	3	8	127	1.138
Middle	12	2	2	0	185	1.167	34	2	2	6	157	1.147
Jr. High	24	2	2	2	171	1.125	68	10	5	4	111	1.162
Sr. High	61	22	10	14	94	1.377	75	30	15	29	52	1.493

* Some districts had as many as 20 sections

** Some districts predict as many as 60 sections.

Source: Original

section, although one or two districts reported as many as 20 sections. Only at the high school level do more than half of the school districts report offerings in computer science, while more than 75 percent of the lower-level schools do not yet include computing courses in their curricula.

The future, however, seems brighter for computer science in Oklahoma's public schools. Fully three-fourths of the high schools responding plan to offer

computer-related instruction within the next five years. In addition, almost half of the junior high and elementary schools in the survey plan to teach computing courses in the near future. In fact, some districts anticipate offering as many as 60 sections in computer science within the coming five years.

These results certainly lend weight to the conclusion that a market does ~~exist~~ for teachers of computing in Oklahoma. This finding is also supported by the second body of data in our survey. Demand for teachers must be related to demand for the courses they teach, so we asked the district superintendents to indicate both the number of students currently enrolled in computer courses and their best estimate of annual enrollment in such courses five years from now. The data for these questions are summarized in Table 2. The responses accumulated in Table 2 indicate that current enrollments are typically fewer than 30 students per district. In fact, only about 40 percent of the districts reporting had 30 or more students enrolled in computing courses. By 1988, on the other hand, more than 70 percent of the districts project an enrollment of at least 30 students -- and roughly one-third of the districts expect from 100 up to 10,000 students to be involved in computer science courses within the same five-year period!

Still, the most convincing indication of the need for teachers of computing in Oklahoma comes from the response to our direct question, "How many faculty additions do you

TABLE 2

Present and Future Number of Computer Science Students In
Oklahoma Independent School Districts

Students	Present Enrollment By Districts		Future Enrollment By Districts	
	#	%	#	%
Up to 10	13	11.61	2	1.14
10 up to 20	28	25.00	27	15.43
20 up to 30	26	23.21	22	12.57
30 up to 50	14	12.50	26	14.86
50 up to 100	14	12.50	38	21.71
100 up to 1,000	17	15.18	51	29.14
1,000 up to 10,000	0		9	5.14
Totals:	112	100.00	175	99.99

Source: Original

anticipate in this area in the next five years?" The responses, summarized in Table 3, indicate that 110 of the school districts will require additional faculty in the short-term future. Most of the districts will require only one or two additional teachers, but 5 districts indicate they will need 20 additional faculty to meet their needs in computer science. The raw data indicates that the 110 reporting districts will require a total of 305 more teachers in computing; if this proportion holds true for all

of the districts in Oklahoma (including those not answering the questionnaire), the total requirements for additional computer science faculty will approach 700 persons over the next five years. While many of these needs may be met by retraining existing faculty, there is a strong need to insure now that an adequate (and qualified) pool of teachers will exist in the future.

All three of these tables reveal an emphatic answer to our initial question: is there a clear demand within the geographical area for teachers in computer science? The answer is "yes"; a demand already exists for teachers of computing at the high-school level, and it is expected to develop at a startling rate within schools at the other levels. Note in Table 1, for example, that the number of elementary schools expecting to offer at least one section of computing within five years is more than double the current number of schools offering a single section. Among middle schools and junior highs, that number is almost triple the current number of sections offered. While growth is generally expected to be somewhat slower at the high school level, the number of senior high schools teaching 4 or more sections may almost double in the next five years.

Certainly, then, the data indicate a need for teachers of computing, but at this point it is not clear exactly what preparation such teachers need. For example, it appears that many school districts require only one teacher for a single course offering. In such cases, it is reasonable to

TABLE 3

Additional Computer Faculty Needed
In The Next Five Years By School Districts

Added Computer Faculty Needed	No. of Districts	Percentage
1	42	38.18
2	33	30.00
3	13	11.82
4 up to 10	15	13.64
10 and over	7	6.36
Total	110	100.00

Source: Original

think of training teachers in other major areas (such as office administration or math or science) while developing an appropriate minor that would enable them to teach the single section. (Several of our respondents indicated that they will cover these needs by re-training existing faculty from other academic areas.) In other cases, it appears that some districts will in fact be teaching enough students in enough sections to justify hiring full-time specialists in computer science. Can there be any clear guidelines for the College of Education in developing a curriculum that will satisfy both categories of need?

Our research data provides few clear answers to this question, but it does give at least some guidance. We began by asking about the level of training received by teachers already engaged in teaching computer science. Of course, the number of credit hours of preparation is not an adequate measure of a teacher's quality; as one respondent says, Colleges of Education may be too "hang up on sections, courses, and hours." With this reservation in mind, we still believe that the data in Table 4 is significant. Notice that only eight of the responding districts have teachers with 18 or more hours of college computer science credit, and that this figure represents only 10 teachers altogether. Most of the people teaching computing have six or fewer credit hours in the subject. We believe that even the finest teachers will be handicapped in the classroom with such limited background. As a starting place, then, the College of Education should aim for a curriculum which would give prospective teachers greater depth in computing, even when the discipline is considered as a "minor" in support of some other subject.

In order to determine more precisely what kinds of preparation should be made available to prospective teachers, we asked our respondents whether most students engaged in computer courses are bound for college or for regular employment upon graduation. The responses, as shown in Table 5, indicate that in almost 90 percent of the

TABLE 4

Hours of Faculty Computer Training by School Districts

Hours of Computer Credit	No. of Faculty in District					Total*
	1	2	3	4 up to 10	10 or more	
6 hours or fewer	49	33	13	12	3	110
7 up to 12 hours	34	10	7	2	0	53
13 up to 18 hours	33	4	1	1	0	39
18 or more hours	6	2	0	0	0	8

* There is some double counting as some districts reported at more than one level.

Source: Original

districts, 50 percent or more of the students in computing courses are bound for college. This information suggests that teachers of computing in the public schools should be prepared to address the particular needs of the future college student; more specifically, it may indicate a need for teachers able to teach principles of computer programming and operation, rather than strictly vocational skills. (Still, a significant minority of students will enter the work force directly upon completing high school, and they will frequently require basic computer skills for many of the entry-level jobs available. As time passes, there may

TABLE 5

Students Work Bound College Bound, or Unknown by
Districts Reporting

Category	Work Bound		College Bound		Unknown	
	#	%	#	%	#	%
Up to 25%	35	45.45	5	4.72	52	73.24
25 and up to 50%	21	27.27	7	6.60	12	16.90
50 and up to 75%	19	24.68	34	32.08	2	2.82
75 and up to 100%	2	2.60	60	56.60	5	7.04
TOTAL	77	100.00	106	100.00	71	100.00

Source: Original

be a growing need for parallel pre-college and vocational courses in computing, creating a corresponding need for parallel programs within the Colleges of Education.)

Perhaps not surprisingly, there is no clear consensus among the school districts about whether computer science teachers should be more strongly grounded in mathematics or in business. Table 6 summarizes responses about the relative importance of these disciplines to the preparation of teachers. Both disciplines were deemed of roughly equal importance, and both were very highly rated. Over 80 percent of the respondents described both math and business as being "important" or "very important" to teacher training in

Teacher Training in Computers/Business
Versus Computers/Math

Category	Importance Of Teacher Training Computers /Business		Importance Of Teacher Training Computers/Math	
	#	%	#	%
Very Important	100	49.8	98	48.8
Important	74	36.8	77	38.3
Not Sure	11	5.5	11	5.5
Unimportant	0	0.0	0	0.0
Very Unimportant	1	0.5	0	0.0
Missing	15	7.5	15	7.5

Source: Original

computer science. This finding presents some difficulties for the College of Education which plans to prepare teachers for computing courses. The data in Table 6 seem to indicate a need for parallel programs in business and math, rather than for a single program which would endorse one or the other of these disciplines. An alternative would be to create an integrated program of studies encompassing both

math and business courses, in addition to the required in-depth training in computer science. This alternative, while attractive for students majoring in computing, may be difficult to implement for those students who wish to take a minor in the subject. In those cases the parallel degree program may be particularly called for.

Finally, our questionnaire asked the Oklahoma school superintendents to indicate what emphasis they expect their programs in computer science to have -- what are the desired results of computer education? Their responses, summarized in Table 7, are very much as expected. Both large and small schools indicated that "computer literacy" is the primary objective of computer education in the public schools. The learning of the BASIC programming language or of program writing in general is apparently considered to be close behind "computer literacy" as an objective. While word processing skills are also emphasized in a number of districts, there appears to be virtually no demand for learning such languages as COBOL and FORTRAN. These findings seem to correspond to a number of general trends in computer science education at all levels. While there is certainly no clear definition of what is encompassed by the phrase "computer literacy", there is a real and growing need for people to become familiar with computers, their jargon, and the way they may be manipulated using computer programs. In any event, the public schools are expected to address these needs as a service to their constituencies. Thus, the

College of Education must again consider the marketplace for which it prepares new teachers; in Oklahoma, at least, it would appear to be a mistake to turn out teachers of computing who are prepared strictly in technical or advanced computer science. Wherever possible, it is desirable to train teachers in the broader areas of computer literacy, general programming for small computers, and word processing.

III. CONCLUSIONS

Our research confirms that there is a strong and growing market in the state of Oklahoma for teachers trained in the skills of computing. Barring severe reductions in program budgets, most public schools plan to have at least some level of computer science instruction in their curricula within the next five years. Some of these expanded teaching opportunities will be filled by retraining existing faculty; however, there appears to be a growing demand for specialists prepared specifically to teach computing.

These findings hold several important implications for the College of Education. There is a clear need for greater depth and structure in the preparation of new teachers of computer science. Prospective teachers in Oklahoma should generally be prepared to teach in the broad categories of computer literacy, BASIC programming, and word processing, with a further emphasis in either math or business. In line with current and projected demand, teachers should generally be prepared to teach college-bound students; however, the

need for teachers prepared to teach vocational computing skills will need to be reassessed often.

On the whole, it appears that educators at every level in Oklahoma schools have already begun to prepare for the future in computer education. Schools, colleges, and departments of teacher education must begin now to prepare the teachers who will teach future generations how to use and understand computers. We are behind already!

END NOTES

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